

(19) World Intellectual Property Organization International Bureau



(43) International Publication Date  
10 June 2004 (10.06.2004)

PCT

(10) International Publication Number  
**WO 2004/049498 A3**

(51) International Patent Classification<sup>7</sup>: H01Q 9/16, 21/00

CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, EG, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK (utility model), SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(21) International Application Number:  
PCT/IL2003/000971

(22) International Filing Date:  
17 November 2003 (17.11.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
60/428,280 22 November 2002 (22.11.2002) US

(71) Applicant (for all designated States except US): BEN GURION UNIVERSITY [IL/IL]; P.O. Box 653, 84 105 Beer Sheva (IL).

(72) Inventors; and

(75) Inventors/Applicants (for US only): RAHAMIM, Dayan [IL/IL]; 8/19 Elul Street, 77 100 Ashdod (IL). SHAVIT, Reuven [IL/IL]; 6 Havered Street, 42 815 Pardesia (IL). TABRIKIAN, Joseph [IL/IL]; 26 Eliahu Bet Tsuri Street, 84 673 Beer Sheva (IL).

(74) Agent: G. E. EHRLICH (1995) LTD.; 11 Menachem Begin Street, 52521 Ramat Gan (IL).

(81) Designated States (national): AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ,

(84) Designated States (regional): ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

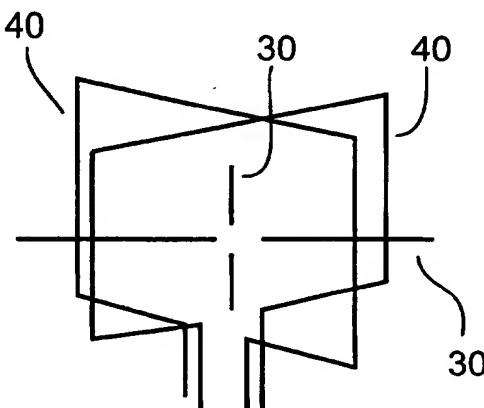
**Published:**

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

(88) Date of publication of the international search report:  
15 July 2004

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SMART ANTENNA SYSTEM WITH IMPROVED LOCALIZATION OF POLARIZED SOURCES



(57) Abstract: An antenna array and signal preprocessing apparatus and method. The antenna array is a quadrature polarized array having two orthogonal electric dipoles (30) and two orthogonal magnetic dipoles (40). The preprocessor is for preprocessing signals from the antenna, for obtaining spatial spectrum information for signal source location. The preprocessor comprises an autocorrelator, connected after said input, for forming signal autocorrelation matrices for each element, and an smoother, connected after said autocorrelator, for averaging said autocorrelation matrices, thereby to form a sample covariance matrix suitable for use in a Eigenstructure based estimator for estimating source localization.

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 25373	<b>FOR FURTHER ACTION</b>	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/IL03/00971	International filing date ( <i>day/month/year</i> ) 17 November 2003 (17.11.2003)	(Earliest) Priority Date ( <i>day/month/year</i> ) 22 November 2002 (22.11.2002)
Applicant BEN GURION UNIVERSITY		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.



It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the Report**
  - a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
    - the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
  - b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing:
    - contained in the international application in written form.
    - filed together with the international application in computer readable form.
    - furnished subsequently to this Authority in written form.
    - furnished subsequently to this Authority in computer readable form.
    - the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
    - the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.
2.  Certain claims were found unsearchable (See Box I).
3.  Unity of invention is lacking (See Box II).
4. With regard to the title,
  - the text is approved as submitted by the applicant.
  - the text has been established by this Authority to read as follows:
5. With regard to the abstract,
  - the text is approved as submitted by the applicant.
  - the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. The figure of the drawings to be published with the abstract is Figure No. 7
  - as suggested by the applicant.
  - because the applicant failed to suggest a figure.
  - because this figure better characterizes the invention.

None of the figures

**INTERNATIONAL SEARCH REPORT**

International application No.

PCT/IE93/00971

**Box III TEXT OF THE ABSTRACT (Continuation of Item 5 of the first sheet)**

The technical features mentioned in the abstract do not include a reference sign between parentheses (PCT Rule 8.1(d)).

**NEW ABSTRACT**

An antenna array and signal preprocessing apparatus and method. The antenna array is a quadrature polarized array having two orthogonal electric dipoles (30) and two orthogonal magnetic dipoles (40). The preprocessor is for preprocessing signals from the antenna, for obtaining spatial spectrum information for signal source location. The preprocessor comprises an autocorrelator, connected after said input, for forming signal autocorrelation matrices for each element, and an smoother, connected after said autocorrelator, for averaging said autocorrelation matrices, thereby to form a sample covariance matrix for use in a Eigenstructure based estimator for estimating source localization.

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL03/00971

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : H01Q 9/16, 21/00  
US CL : 343/726, 727, 793, 795, 797, 810

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
U.S. : 343/726, 727, 793, 795, 797, 810

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
EAST

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6,329,955 B1 (MCLEAN et al) 11 December 2001 (11.12.2001), see entire document.	1-47
A	US 2,953,782 A (BYATT) 20 September 1960 (09.20.1960), Figure 3.	1-47
X	US 6,211,846 B1 (GOUIN) 03 April 2001 (03.04.2001), Figure 1; columns 2-4.	1, 3-11, 13-20
---		-----
Y		12
X	US 6,437,750 B1 (GRIMES et al) 20 August 2002 (20.08.2002), Figures 1A, 1B; column 12, line 25 - column 13, line 2.	1, 3-11, 13-20
---		-----
Y		12

Further documents are listed in the continuation of Box C.



See patent family annex.

Special categories of cited documents:	
"A"	document defining the general state of the art which is not considered to be of particular relevance
"E"	earlier application or patent published on or after the international filing date
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O"	document referring to an oral disclosure, use, exhibition or other means
"P"	document published prior to the international filing date but later than the priority date claimed
"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&"	document member of the same patent family

Date of the actual completion of the international search

16 April 2004 (16.04.2004)

Date of mailing of the international search report

07 JUN 2004

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450

Faxsimile No. (703) 305-3230

Authorized officer

Trinh Vo Dinh

Telephone No. (571) 272-1821

Form PCT/ISA/210 (second sheet) (July 1998)

**BEST AVAILABLE COPY**